

REMARKS

Applicants are amending their claims in order to further clarify the definition of various aspects of the present invention. Specifically, claims 1 and 8 have been amended to incorporate therein the subject matter of previously considered claim 4 (that is, to recite that a thickness of the first layer ranges from 2nm to 10nm). In light of this amendment of claim 1, claim 4 has been cancelled without prejudice or disclaimer. Moreover, claim 6 has also been cancelled without prejudice or disclaimer.

Initially, it is respectfully requested that the present amendments be entered. Noting that amendments to claims 1 and 8 incorporate the subject matter of claim 4 therein, it is respectfully submitted that the present amendments do not raise any new issues, including any issue of new matter. Moreover, by incorporating subject matter of claim 4 into claims 1 and 8, at least any issues remaining for appeal are simplified, the present amendments materially limit any issues remaining for appeal. Noting additional contentions by the Examiner in the Office Action mailed November 18, 2003, as well as simplification of the prior art rejections therein, it is respectfully submitted that the present amendments are clearly timely.

In view of the foregoing, it is respectfully submitted that Applicants have made the necessary showing under 37 CFR §1.116(c); and that, accordingly, entry of the present amendments is clearly proper.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the

references applied by the Examiner in rejecting claims in the Office Action mailed November 18, 2003, that is, the teachings of United States Patent Documents No. 2002/0018917 to Sakai, et al., No. 2002/0012816 to Shimizu, et al., No. 5,763,071 to Chen, et al. and No. 5,851,643 to Honda, et al., under the provisions of 35 USC §102 and 35 USC §103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a perpendicular magnetic recording medium as in the present claims, or such magnetic storage apparatus using such medium as in the present claims, wherein the medium includes a first layer formed on an opposite side of a magnetic layer relative to the substrate, the first layer including an amorphous alloy layer containing rare earth metals and 3d transition metals as a main component, this first layer having a thickness ranging from 2nm to 10nm, with a second layer, containing Co and Cr, formed on the first layer. See claim 1; note also claim 8.

Moreover, it is respectfully submitted that the applied references would have neither taught nor would have suggested such perpendicular magnetic recording medium as in the present claims, having features as discussed above in connection with claim 1; and, moreover, wherein a thickness of the second layer ranges from 0.5nm to 10nm (see claim 7); and/or wherein the first layer, which includes the amorphous alloy layer containing rare earth metals and 3d transition metals as a main component, is a multi-layer film containing the amorphous alloy layer and other layers (see claim 2), especially wherein this multi-layer film, which is the first layer, is

composed of the specified amorphous alloy layer containing Co and Cr as a main component (see claim 3); and/or wherein the first layer contains one of TbFeCo, TbCo and TbFe as a main component (see claim 5); and/or wherein the magnetic layer is the main recording layer of the recording medium (see claim 9); and/or wherein the first layer is a thermal-stabilizing layer of the recording medium (see claim 11); and/or wherein the second layer is provided on the surface of the first layer (note claim 12); and/or the additional structure of the protective and lubricant layer on the second layer (note claim 13), particularly wherein this protective and lubricant layer includes carbon, with the second layer suppressing reaction of the carbon (see claim 14), more particularly wherein this protective and lubricant layer is made of a material selected from the group consisting of carbon, silicon carbide and boron carbide (note claim 15).

The present invention is directed to a perpendicular magnetic recording medium having excellent thermal stability, and which is suitable for high density magnetic recording.

There are both longitudinal and perpendicular magnetic recording systems used in magnetic disk apparatuses. The perpendicular magnetic recording system is one which forms recorded bits so that a magnetization direction of the recording medium is perpendicular to a medium surface, and magnetization directions in recorded bits adjacent to each other are in anti-parallel.

As a perpendicular magnetic film, a Co alloy having a hexagonal close-packed structure is mainly used; on the other hand, materials other than CoCr-

based alloy series materials have been used as perpendicular magnetic recording materials, such as amorphous alloys made of rare earth-transition metals. Also, a thin film formed of a multilayer film, such as $(\text{Co/Pd})_n$ and $(\text{Co/Pt})_n$, has been investigated, these multilayer films having alternatively laminated Co films with films of Pd or Pt. Note, in particular, the paragraph bridging pages 2 and 3 of Applicants' specification.

As described in the paragraph bridging pages 3 and 4 of Applicants' specification, CoCr-based alloys do not have sufficient resistance to thermal fluctuations. On the other hand, while perpendicular magnetic recording media made of amorphous alloys of the rare earth-transition metals, and made of multilayer films, as discussed previously, are excellent in thermal stability and signal-to-noise ratio at low recording densities, perpendicular magnetic recording media made of these materials have a problem that noise at high recording densities is large. Note the paragraph bridging pages 3 and 4 of Applicants' specification. In addition, recording films made of these materials have additional problems in that it is difficult to manufacture the multilayer films, and the rare earth-transition metal alloys, which contain corrosive rare earth metals, have poor corrosion resistance.

In addition, a further problem found by the present Applicants is that when a rare earth-3d transition metal amorphous alloy is used as the recording layer, this layer and carbon used as a protective film react with each other, so that sufficient thermal stability and signal-to-noise ratio cannot be obtained at a thin area in which

a thickness of the recording layer is equal to several nm or less. Again, note the paragraph bridging pages 3 and 4 of Applicants' specification.

Against this background, Applicants provide a perpendicular magnetic recording medium, and a magnetic storage apparatus using this perpendicular magnetic recording medium, avoiding problems as discussed previously; and, in particular, providing structure excellent in thermal stability and having a high signal-to-noise ratio, and being suitable for high density magnetic recording. Applicants have found that by providing structure including a magnetic layer containing Co and Cr as main components, with a first layer formed on this magnetic layer, the first layer including an amorphous alloy layer containing rare earth metals and 3d transition metals as a main component, this first layer having a thickness of 2nm to 10nm, and with a second layer formed on the first layer, the second layer containing Co and Cr, objectives according to the present invention are achieved, and in particular a perpendicular magnetic recording medium having good thermal stability and good signal-to-noise ratio, and being suitable for high density magnetic recording, is achieved.

It is emphasized that, in accordance with the present invention, by using the first layer sandwiched between the magnetic layer containing Co and Cr as the main component and the second layer containing Co and Cr, with a thickness of this first layer being in a range 2nm and 10nm, magnetic wall motion can be prevented, so that thermal stability in recording magnetization, and S/N ratio, can both be improved.

In this regard, attention is respectfully directed to the paragraph bridging pages 12 and 13, the sole full paragraph on page 13, and the paragraph bridging pages 13 and 14, of Applicants' specification, together with Figs. 4 and 5. Note especially Fig. 4 and the description in connection therewith, in the paragraph bridging pages 12 and 13 of Applicants' specification. As particularly seen in Fig. 4, the S/N ratio significantly decreases when the first (thermally-stabilizing) layer thickness is greater than 10nm. As seen in the paragraph bridging pages 13 and 14 of Applicants' specification, as the thickness of the thermally-stabilizing layer becomes thicker, influences of exchange coupling in the thermally-stabilizing layer 15 becomes relatively significant; and the S/N ratio decreases to be lower than that of a sample of a CoCrPt single layer without the thermally-stabilizing layer when the thickness of the thermally-stabilizing layer 15 increases above 10nm. While the thickness of the thermally-stabilizing layer should be thicker from the viewpoint of thermal stability, Applicants have found that the thermally-stabilizing layer has an optimum in consideration of the S/N ratio; and that by setting the thickness of the thermally-stabilizing layer to be in a range of 2-10nm, a medium which is thermally stable and shows a high S/N ratio can be obtained.

It is respectfully submitted that Applicants' original disclosure shows unexpectedly better results achieved according to the present invention, having a first (thermally-stabilizing) layer of thickness in a range of 2-10nm, and that this constitutes evidence in Applicants' original disclosure that must be considered in determining patentability. See in re DeBlauwe, 222 USPQ 191(CAFC 1984).

Particularly in view of this evidence of unexpectedly better results, it is respectfully submitted that Applicants have clearly established unobviousness of the presently claimed subject matter.

In addition, Applicants achieve additional advantageous effects through use of the first layer, with the cap layer as in the present invention. Thus, as stated, for example, in the first full paragraph on page 8 of Applicants' specification, the magnetic layer made of the amorphous alloy containing the rare earth metals and the 3d transition metals as a main component is used as a thermally stabilizing layer, on the main recording layer of Co and Cr. In addition, a cap layer of Co and Cr is formed on the surface of the thermally stabilizing layer. By including the cap layer, squareness is increased, and by sandwiching the thermally stabilizing layer between the alloy films containing Co and Cr as the main components, a magnetic wall motion is suppressed, so that an effect of an increase in a S/N ratio in addition to an increase in thermal stability of recorded magnetization can be obtained. Note the sole full paragraph on page 8 of Applicants' specification.

In addition, by providing the thickness of the second layer as in various of the present claims (see claim 7), thermal stability is improved due to suppressing a reaction of material of the first layer with carbon of the protective and lubricant layer, and by suppressing corrosion; and, moreover, the S/N ratio increases due to suppression of the magnetic wall motion by sandwiching the thermally stabilizing layer between the alloy films contained in Co and Cr as the main component. See the two full paragraphs on page 11 of Applicants' specification.

As to advantages achieved according to the present invention, attention is respectfully directed to the Examples and comparisons thereto as set forth in the Embodiments in Applicants' disclosure. Note for example, Embodiments 1-6 on pages 8-23 of Applicants' specification. It is respectfully submitted that the Embodiments show advantages achieved by various aspects of the present invention, including use of the first (thermally stabilizing) layer and second (cap) layer, particularly together with the protective and lubricant layer, as well as thicknesses of the first (thermally stabilizing) and second (cap) layers.

Sakai, et al., discloses a perpendicular magnetic recording medium that is mounted on various magnetic recording devices. In one embodiment, this patent document discloses that the magnetic recording layer is constructed from a magnetic layer of at least two or more layers, with at least one of the layers being a magnetic layer of a rare earth-transitional metal alloy amorphous film. See paragraph [0014] on page 1 of this patent document. Note also paragraphs [0010], [0011], [0015] and [0018] on page 1. In paragraph [0048] on page 3 of this patent document, there is disclosed a structure having a TiCr undercoat film of 10nm thickness, a CoCrPtTa magnetic layer of 10nm thickness and a TbCoCr magnetic layer of 20nm thickness. Note also paragraph [0052] on page 4, also describing a multi-layer magnetic recording layer having a TbCoCr film where a film thickness of 20nm.

It is respectfully submitted that Sakai, et al. would have neither disclosed nor have suggested, and in fact would have taught away from, a perpendicular magnetic

recording medium as in the present invention, having a thickness of the first layer ranging from 2nm to 10nm. In regard thereto, it is emphasized that Sakai, et al., in examples thereof, describe a layer thickness of 20nm. It is respectfully submitted that such disclosure teaches away from the present invention wherein the first layer has a thickness of 2-10nm. Particularly, in view of advantages achieved by the present invention having the thickness 2-10nm of the first layer, it is respectfully submitted that Sakai, et al., would have neither taught nor would have suggested the present invention, and advantages thereof.

The contention by the Examiner on page 6 of the Office Action mailed April 24, 2003, that the thickness of each magnetic layer is a cause-effective variable, and that it would, therefore, have been obvious to one having ordinary skill in the art to have determined the optimum value of a cause-effective variable such as the thickness, through routine experimentation, is respectfully traversed. Initially, as clearly established by the evidence of record, the thickness of the first layer as presently claimed provides unexpectedly better results, thus establishing importance of such thickness for aspects of the present invention. Moreover, it is again emphasized that Sakai, et al., disclosing a relatively large thickness of 20nm, and thus would have taught away from the thickness range of the first layer as in the present claims, and the resulting advantages achieved through use of the first layer having the recited thickness, in combination with the other structure of the medium according to the present invention.

It is respectfully submitted that the additional teachings of Chen, et al., would not have rectified the deficiencies of Sakai, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art. Chen, et al., discloses thin film magnetic disks including a non-magnetic substrate; a Cr or Cr-alloy underlayer formed on the substrate; a first magnetic layer which is magnetically anisotropic formed on the Cr or Cr-alloy underlayer; and a second magnetic layer which is magnetically isotropic, formed directly on the first magnetic layer, the magnetic recording medium having a specified areal recording density and a specified Mrt. Note the paragraph bridging cols. 2 and 3 of this patent. See also col. 3, lines 16-30. This patent discloses that each magnetic layer of the magnetic recording medium can typically be deposited at a thickness of about 5Å to about 200Å, and, together, the first and second magnetic layers constitute a first pair of magnetic layers exhibiting a substantially single coercivity. See col. 4, lines 33-38. Note also col. 5, lines 58-64, and col. 6, lines 2 and 3, describing a specific embodiment having magnetic layers 22 and 23 each having a thickness of about 5Å to about 200Å.

Initially, Applicants maintain their position that the teachings of Chen, et al., are not properly combinable with the teachings of Sakai, et al., under the requirements of 35 USC §103. It is respectfully submitted that Sakai, et al. and Chen, et al. are directed to different technologies, and address different problems; that one of ordinary skill in the art concerned with in Sakai, et al. would not have

looked to the teachings of Chen, et al. for the problem addressed in Sakai, et al.; and that, accordingly, these references are directed to non-analogous arts.

Thus, Sakai, et al. is directed to a perpendicular magnetic recording medium, while Chen, et al. is directed to a magnetic recording medium having magnetically isotropic and anisotropic layers. Sakai, et al. is concerned with such perpendicular magnetic recording media, and is concerned with avoiding problems arising in connection therewith, of thermal fluctuation, while providing a good S/N ratio and achieving a high recording density. Chen, et al., does not disclose perpendicular magnetic recording media, and is directed to providing a medium having a high areal recording density. This shows that different technologies and different problems are involved in each of Sakai, et al. and Chen, et al., such that the teachings of these references, as applied by the Examiner, are not properly combinable.

In the first full paragraph on page 6 of the Office Action mailed November 18, 2003, the Examiner contends that Chen, et al., is analogous art to Sakai, et al., since the relied-upon teaching in Chen et al. is merely that one can form multiple magnetic layers sequentially deposited on one another and ordered to increase the areal recording density, something which is desired in all types of recording media, longitudinal and perpendicular included. However, it must be emphasized that the Examiner must consider each of the references as a whole, and cannot ignore portions of the references. Taking the teachings of Chen, et al. as a whole, this reference is directed to providing the recording medium with the recited areal density and Mrt, with respectively magnetically anisotropic and

magnetically isotropic first and second magnetic layers. Taking the teaching of Sakai, et al. and Chen, et al., as a whole, as required under 35 USC §103, is respectfully submitted that the teachings of these references are directed to non-analogous arts, as contended by Applicants previously.

In addition, particularly in view of differences in technologies and problems addressed, in Sakai, et al. and Chen, et al., is respectfully submitted that the Examiner has not established proper motivation for combining the teachings of these two references. As can be appreciated, 35 USC §103 requires a proper motivation for combining teachings of the references, and that such motivation must be independent of Applicants' disclosure of their invention.

In any event, even assuming, arguendo, that the teachings of Sakai, et al., and of Chen, et al. were properly combinable, such teachings would have neither disclosed nor would have suggested the presently claimed invention, including the first and second layers, the first layer having the recited thickness, and advantages thereof, or other aspects of the present invention as discussed in the foregoing.

It is respectfully submitted that the additional teachings of Honda, et al. and Shimizu, et al. would not have rectified the deficiencies of the combined teachings of Sakai, et al. and Chen, et al., even were the teachings of Sakai, et al., and Chen, et al. properly combinable, such that the presently claimed as a whole would have been obvious under 35 U.S.C. §103.

Honda, et al., discloses a magnetic recording system which uses magnetic recording media suitable for high-density magnetic recording, the media including a

thin-film control structure, that is, a crystal growth control layer, on a substrate; a non-magnetic layer over the control structure; and an epitaxially formed stacked magnetic film, on the non-magnetic layer structure, so that the stacked film is constituted by layering compositionally different magnetic thin-films (magnetic layers). See column 4, lines 55-65. Note also column 5, lines 25-33. The patent discloses that the magnetically easy axis, that is, the c-axis, of the magnetic thin-film is oriented parallel to the substrate surface. See column 5, lines 9-11. This patent goes on to state that the magnetic thin-film particle size (to emphasize, this disclosure is of the particle size, not layer thickness) should be in the range of 10-50nm, with the magnetic particles being isolated in the medium. See column 5, lines 15-19. This patent goes on to state that coercivity of 2000 Oe or more can be obtained for stacked magnetic thin-films of thicknesses 30nm or below and particularly for thicknesses of 15 nm or below. See column 5, lines 41-44. See also column 13, lines 25-36.

Shimizu et al. discloses a magnetic recording medium employed in a magnetic disk apparatus, having a substrate, a first perpendicular magnetic film, and a second perpendicular magnetic film, in order, with the magnetic anisotropy energy of the first perpendicular magnetic film being higher than that of the second perpendicular magnetic film. See paragraph [0009] on page 1, together with Fig. 1 and paragraph [0019] on page 1, of Shimizu et al. This patent document discloses that the first perpendicular magnetic film 3 preferably has a thickness of 1-175 Å, or preferably 1-100 Å, and that this first perpendicular magnetic film may be a

multi-layer film in which layers of Co material and Pt or Pd material are repeatedly stacked. See paragraphs [0024] and [0029] on page 2 of this patent document. Note also the description of the second perpendicular magnetic film, in paragraphs [0046] to [0048] on pages 2 and 3 of Shimizu, et al.

Even assuming, arguendo, that the teachings of Shimizu, et al. and of Honda, et al. were properly combinable with the teachings of Sakai, et al. and of Chen, et al., such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including the various layers with the first layer having the thickness of 2-10nm and advantages thereof.

In view of the foregoing, entry of the present amendments, and reconsideration and allowance of all claims remaining in the application, are respectfully requested.

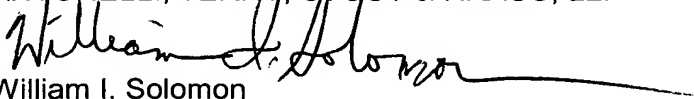
To the extent necessary, Applicants petition for an extension of time under 37 CFR § 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135

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Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP


William I. Solomon
Registration No. 28,565

1300 North Seventeenth Street
Suite 1800
Arlington, Va 22209
Telephone: 703/312-6600
Fax: 703/312-6666
WIS/pay/sjg